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(71) Applicant(s)
RECORDING INDUSTRY TRADING COMPANY
LIMITED
54 Regent Street, LONDON, W1B 5RE,
United Kingdom

(72) Inventor(s)
Richard Michael Gooch

(74) Agent and/or Address for Service
R.G.C.Jenkins & Co
26 Caxton Street, LONDON, SW1H ORJ,
United Kingdom

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(54) Abstract Title
A CD copy protection method and a method for restricting internet file downloads

(57) To prevent unauthorised copying of compact discs, portions of the audio file are corrupted by recording absolute time non-monotonically. This has little effect when the CD is played in a CD player, but disrupts the digital extraction of data from the CD when using a PC-based CD-ROM drive. Authorised users can repair the corrupted portions by accessing uncorrupted portions encoded into the subcode channel. Alternatively, repair patches can be encoded in the program area of the disc. A degraded file may be stored on CD, flash memory, or on a web server, with the repair data being stored on a smart card or a second web server subject to secure access control.
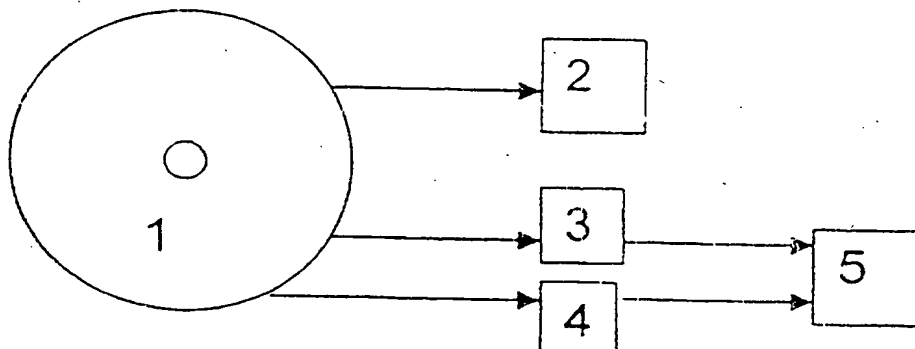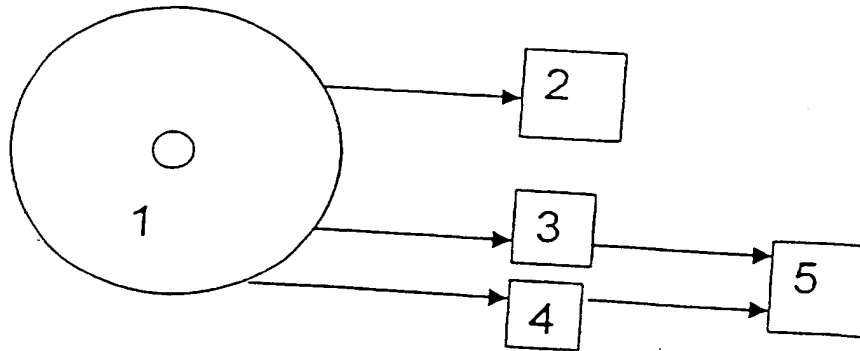
Figure 1

BEST AVAILABLE COPY

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Figure 1

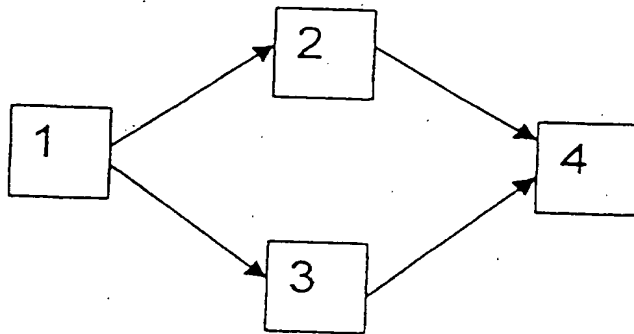Figure 2

COPYRIGHT PROTECTION SYSTEM AND METHOD

Field of the Invention

5   The present invention relates to a system and method for copy-control of digital content carried on a data carrier such as a compact disc. The system provides copyright protection by restricting the copying of digitally represented matter, principally but not exclusively digital audio, whilst providing access controls which enable authorised extraction and usage of the digital data.

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Background to the Invention

A persistent problem in the field of consumer audio has been the difficulty of providing practical support for the legal protection offered by copyright law for

15   products of the recording industry. This practical difficulty arises because products of the recording industry are widely distributed on carriers such as CD which carriers have found widespread use in other industries such as the computer and IT industries.

Copyright Protection

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Copyright protection systems such as the serial copy management system (SCMS) agreed between the recording industry and the consumer electronics (CE) industry, have worked well for those industries. However the computer and IT industries have developed products which whilst not adhering to copyright protection systems such as

25   SCMS, do incorporate the functionality of audio playing and copying equipment. There is thus a general need for a new copy-protection system specific to the products of the recording industry, which system provides copy-protection against general purpose equipment which services generic copying of data.

30   ### Compatibility with Current Equipment and Standards

One proposed solution lies in the development of entirely new data carriers and new equipment including players and copying devices, which carriers and equipment incorporate new copy-protection standards. An example is the development of DVD-

Audio equipment and disc standards which describe audio watermarking and encryption means to facilitate copy-protection. However there is a large established market and installed base of older equipment particularly CD-Audio players and products. Therefore there is a general need for a copy-protection system specific to

5 the products of the recording industry, which system is compatible with existing standards and therefore should not impact upon normal legitimate usage nor require changes to the installed base of hardware.

Compatibility with Products of the Computer and IT Industries

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Since the technical standards underlying data carriers such as CD support audio data in fundamentally the same way as those standards support data of the IT and computer industries, equipment types have been developed such as personal-computer (PC) based CD players and CD-R copiers which support dual use both as general purpose

15 data-storage devices and as devices for accessing and copying products of the recording industry. The computer industry has asserted that general purpose equipment would not comply with copyright protection measures, in particular with SCMS, hence it has in practice proved difficult to find copyright protection schemes which have practical utility in protecting products of the recording industry whilst

20 being compatible with the demands of the computer and IT industries. Therefore there is a general need for a new copy-protection system specific to the products of the recording industry, which system is compatible with the general-purpose equipment of the computer and IT industries to the extent that the copy-protection system is effective against copying with such equipment without any requirement to

25 modify such equipment to incorporate specific copy-protection systems such as SCMS.

Copy-Protection

30 The "Compact Disc System Description" Version August 1995, published by Philips Consumer Electronics B.V., Eindhoven, The Netherlands, and prepared in co-operation with Sony Corporation, Tokyo, Japan, known as the "Red Book" standard, provides specifications for CD-Audio discs and equipment. Copy protection methods for CD-Audio may be implemented by producing CD-Audio discs which do not

adhere to the Red Book standard for CD-Audio. Such non-compliance with the Red Book may be used to produce a copy-protected audio CD which protection does not prevent the audio CD from being played in a standard CD player but which protection disrupts the digital data-extraction process by which audio data is copied from its original carrier, typically a CD, to a second carrier, typically a computer memory, a computer disk drive, or a CD-R disc.

There are many potential methods to achieve the protection of an original CD against extraction of data using CD and CD-R equipment installed in a computer. Such methods may be broadly categorised into three categories as follows: (1) Methods which employ manipulation of the disc table of contents (TOC). For example the starting address of the lead-out may be deliberately written incorrectly in the TOC, much in advance of the actual starting address of the lead-out – thus preventing normal playing of the disc using PC based CD players which are often programmed to prevent access to data on the disc beyond the starting address of the lead-out; (2) Protection methods which place data-structures on an audio CD which structures are intended to cause any PC based player to process the disc as a CD-ROM or as a multi-session disc. For example a short computer program may be inserted prior to the audio program area, which computer program will be executed by a PC into which the disc is inserted and where the program execution is intended to disrupt or prevent the extraction of audio data using computer-based CD or CD-R equipment. The program data may be 'hidden' with respect to audio play operations by placing the data in an 'extended pre-gap' on the disc; (3) Methods which manipulate the Red Book encoding standards in order to hinder digital data-extraction from the disc. For example the Red Book describes features of the CD encoding method by which time and index data are encoded in the 'sub-code channels'. This time and point information facilitates, among other things, the digital data-extraction of blocks of audio data from the disc, but which information itself is of limited use in playing the disc in a standard CD player. If the time and point information are written to the CD in certain ways which deliberately contravene the Red Book standard, then this may prevent accurate seeking of data blocks and frames during the extraction of digital audio data such that there will be errors in the extracted data which will cause audible artefacts upon playing the extracted data. However as noted the time and point

subcode data is of limited use in playing an original CD in an audio player, therefore the original CD will not yield audible artefacts upon playing of that original CD.

Access Controls

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A problem faced by these copy-protection technologies is that, if they are implemented to provide effective protection against extraction of digital audio data thus preventing the production of infringing copies, they therefore prevent extraction for legitimate usage of that data — such as the importation of that data into portable

10   players of the type being developed under the secure digital music initiative (SDMI), SDMI Secretariat, c/o SAIC, 10260 Campus Point Dr, San Diego, CA 92121, USA and also the legitimate extraction of digital audio data for rendering through high-quality audio rendering systems such as the Meridian 800 Reference DVD/CD Player produced by Meridian Audio Ltd, Stonehill, Stukeley Meadows, Huntingdon,

15   Cambridgeshire, PE18 6ED, England

Therefore there is a general need for a new copy-protection system specific to the products of the recording industry, which system is effective against copying of recording industry products and where the copy-protection system is provided with

20   access controls which provide for extraction of data into specific legitimate applications.

Data Storage for Recording Industry Content

25   In order to provide a copy-protection system with access controls there is therefore a general need for a data-storage system which uses and is compatible with standard players, which provides effective protection against the extraction of digital content data for infringing uses, which is effective against but compatible with generic products of the computer and IT industries and which storage system provides access

30   controls which provide for extraction of data into specific legitimate applications without such access undermining the protection afforded against unauthorised copying using generic data-extraction or copying equipment. A consequence of providing a recording-industry specific data-storage format together with access controls is the avoidance of conflict between the requirement of the computer and IT

industries to provide generic tools, and the legitimate requirement of the recording industry to provide practical protection against infringing use of it's products.

To avoid inconvenience to the consumer and to established markets, this new data-
5   storage system may utilise the current standards for data carriers, but augment these standards with data structures which provide:

- Compatibility with installed audio player hardware
- Copy-protection for products of the recording industry
10   - Ability to extract digital audio data for authorised usage by compliant systems

15   <u>Statement of the Invention</u>

According to a first aspect of the present invention, there is provided a data-storage system comprising a physical carrier such as a CD which carries a first content file of data, the first content file being protected by a copy-protection system which restricts
20   access to the first content by causing data-errors to be introduced into data extracted from the carrier, the data-storage system providing controlled access to the first content file by providing a second content file of data which is used to correct data-errors in the data extracted from the first content file.

25   It shall be understood that the term 'content file' is intended to cover terms such as 'content', 'data' and 'content file of data' and in particular, but not exclusively, applies to recording-industry content such as audio data or audio data in combination with additional data including text, graphics, software or video data.

30   It shall be understood that the term 'data carrier' is intended to cover any physical media used to carry any content file of data particularly, but not exclusively, optical disc media including CD, CD-R, DVD-Audio and MiniDisc.

It is recognised in the art that a copying process by which a first content file on a first carrier is copied to an equivalent content file on a second carrier implies subsidiary processes under which data is extracted from the first carrier and transferred to the second carrier, and which processes operate on data which may in whole or in part represent the first content file, such that the extraction and transfer processes may be carried out repeatedly with respect to portions of the first content file until a complete copy of the first content file is present on the second carrier. By introducing data-errors into data extracted from a carrier, the copy-protection system prevents a first content file stored on a first data carrier from being reproduced as an equivalent content file on a second data carrier, since by introducing degradations or detrimental modifications into data extracted from the first content file then these degradations or detrimental modifications will be present in the content file stored on the second carrier where they were not present in the first content file stored on the first carrier.

It shall be understood that the terms 'detrimental modification' and 'degradation' are intended to cover any detectable reduction in quality, with respect to a first content file of data, of any copy of that first content file of data. In particular with respect to a file of audio data, such detrimental modification or degradation should, upon playing or otherwise rendering the copy of the first content file, result in the presence of detectable audible artefacts in the audio, where these audible artefacts were not present upon playing or rendering the first content file.

According to the present invention, is provided a second content file of data which may be used to repair the degradation of the data extracted from the first content file by which means a further content file equivalent to the first content file may be produced on the second carrier by the step of: extracting degraded data from the first content file; accessing the second content file of data; applying a method of repairing the degradations in the extracted data using the second content file of data; and transferring the repaired extracted data onto a second carrier.

The term 'repair' shall be understood to describe a method by which the copy of the first content file shall be restored from its degraded form to a form equivalent to the first content file. With respect to a file of audio data, the repair shall achieve the effect that, whereas upon playing or rendering the degraded copy of the first content

According to a third aspect of the present invention, there is provided a copy-protection method which uses a data-storage system comprising a first content file stored on a data carrier, the first content file being protected by a copy-protection system which restricts access to the content by causing data-errors to be introduced into data extracted from the first carrier, the data-storage system providing controlled access to the content by providing a second content file of information which is used to correct data-errors in the data extracted from the first content file, comprising the method steps of; storing a first content file on a carrier arranged to provide a copy-protection means being further arranged to introduce data-errors into data subsequently extracted from the first content file stored on the first carrier; providing access to a second content file arranged to provide information which may be used to repair data-errors in data extracted from the first content file carried by the first carrier; a method and apparatus provided for effecting a repair to data extracted from the first content file; storing the repaired data extracted from the first content file on a second carrier.

According to a fourth aspect of the present invention, there is provided a data-access method which uses a data-storage system comprising a first content file stored on a data carrier, an intermediate content file containing data extracted from the first content file which intermediate content file contains data-errors introduced by a copy-protection system, the data-storage system providing a second content file of information for the purpose of correcting data-errors in the intermediate content file, comprising the method steps of; accessing an intermediate content file which contains data extracted from a first content file where the intermediate content is arranged to contain data-errors with respect to the first content file; accessing a second content file arranged to provide information which may be used to repair data-errors in data extracted from the first content file carried by the first carrier; the application of a method or apparatus for effecting a repair to data extracted from the first content file; storing the repaired data extracted from the first content file on a second carrier.

The scope of this invention extends to any data-storage system arranged to provide a physical carrier which stores or encodes a first content file protected with a copy protection system together with a second content file which may be used to repair a degraded copy of the first content file. This invention further extends to any carrier

which carries a first content file and which carries a second content file for the purpose of repairing a degraded copy of the first content file. This invention also extends to any second content file on any carrier which file is provided for the purpose of repairing any copy of a first content file which first file might be degraded

5   as a consequence of being copied. This invention also extends to any carrier which carries a second content file which file may be used to repair a degraded copy of a first content file. This invention also extends to any file of data stored on any carrier, which data has been produced as a result of repairing a degraded copy of a first content file using a second content file. This invention also extends to any carrier

10   which carries a content file which content file has been produced as a product of the process of repairing a degraded copy of a first content file using a second content file. This invention also extends to any method and process for preparing a second content file for the purposes of repairing a degraded copy of a first content file. This invention also extends to any process or method or apparatus or equipment by which a

15   degraded copy of a first content file may be repaired using any second content file, whether a physical apparatus or a computer program or process which implements the function of that apparatus. This invention also extends to any tools for example glass-masters, produced directly for the purpose of manufacturing an embodiment of data-storage systems or copy-protection systems according to this patent, including

20   intermediate tools for example mothers and stampers required at intermediate stages in the production of CDs, which tools or intermediate tools are used for the purpose of manufacturing an embodiment of data-storage systems or copy-protection systems according to this patent.

25   Brief Description of Drawings

A specific embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

30   Figure 1 schematically illustrates a data-access system comprising a data-carrier 1, carrying a content file 2 which is accessible by playing the carrier disc in an audio player but which, upon extracting a digital copy of the content yields a degraded file 3 containing data-errors, but which carrier also yields through an access control system

(not shown) a second file 4 which is usable together with the extracted degraded file 3 to produce a non-degraded copy 5 of the content file 2.

Figure 2 schematically illustrates a data-access system comprising a first content file
5   1, from which is derived an intermediate degraded file 2 containing data-errors, and which intermediate file may be stored on an intermediate carrier and/or transferred using data-communications means, and from which first content file 1 is derived a second file 3 which is usable together with the degraded file 3 to produce a non-degraded copy 4 of the content file 1.
10

Description of Embodiment

The embodiment below is described with reference to the application of the present
15   invention in copy-protecting an audio CD.

Creation of a Protected Data Carrier

An initial step in the commercial production of CD-Audio discs involves the use of a
20   laser beam recorder (LBR) in recording a first content file, in this example containing audio "tracks", onto a glass-master. From the glass master are produced a number of intermediate tools for producing CD's by the injection-moulding process, and in particular are produced 'stampers' which incorporate a pattern of pits which pits encode the audio tracks as well as subcode information. Stampers are used within an
25   injection moulding machine to mould optical polycarbonate substrate material which forms the bulk of the produced CD disc. According to techniques known in the art, and for the purposes of the current description, a copy-protection scheme is employed at this glass mastering stage of production in order to protect the subsequently produced CDs against unauthorised copying using CD-R recording equipment. For
30   example one such copy-protection technique is to record the absolute time in the sub-code channel so that the absolute time is non-monotonic in at least one part of the information area of the disc. Thus in the present embodiment the LBR is controlled to write the absolute time in a pre-determined non-monotonic fashion which will have little or no impact on the normal operation of a subsequently produced CD when that

CD is played in an audio CD player, but which will disrupt the digital extraction of data from that CD using a PC based CD-ROM drive. As is known in the art, such a copy-protection technique will thus protect against digital data extraction using PC equipment and therefore protect against the production of infringing copies of the

5 original CD using a CD-R recorder. A problem is that it will therefore not be possible to extract data from the protected CD for legitimate purposes such as for playing in an SDMI portable device player. According to the present embodiment, a second content file of data is encoded into the subcode channel and recorded by the LBR onto the glass master. It will be understood by a reader skilled in the art, that there are many

10 possible methods of interest for encoding at least one second content file into the data recorded onto the glass master for example by manipulating the bits of the lead-in, lead-out, the merging bits, or any of the eight subcode channels. For the purposes of illustrating the present embodiment only, a specific example is presented where 98 bits of PCM audio data are written in the R subcode channel of each frame of the

15 program area to provide an auxiliary channel giving 7350 bits per second. It will be appreciated that many alternative solutions are possible according to the present invention. This second content file contains extracts of data copied from the portions of the first content file corresponding to those portions of the first content file at which the absolute time is recorded non-monotonically on the glass master. The

20 second content file is encoded in the subcode channel in locations which correspond to areas on the glass master at which the absolute time is recorded monotonically. Thus a CD produced from this glass master will play normally in the majority of audio CD players which do not refer to the absolute time data encoded in the subcode channel during normal play operation. Upon extracting digital data from the disc

25 using the majority of PC based CD-ROM drive there will be errors in the extracted data corresponding to those points at which the absolute time was recorded non-monotonically. However in the present embodiment, by extracting the corresponding portions of the first content file which were provided in the second content file encoded in the sub-code channel, the errors in the extracted data may be repaired to

30 provide a substantially error-free copy of the first content file.

Preferably, the number of points at which the absolute time is recorded non-monotonically is sufficiently few in number that there is sufficient storage capacity in

the subcode channel to store a second content file which contains all the data required in order to repair all errors arising in the extraction process.

Preferably, the number of points at which the absolute time is recorded non-monotonically is sufficiently many in number that the consequent errors arising in data extracted without the benefit of repairs afforded by the second content file, are of sufficient number that they represent a significant degradation of the quality of the extracted data with respect to the original data contained in the first content file. Advantageously, where the first content file contains audio tracks and data extracted from the first content file is not corrected using the second content file, then upon playing or rendering the extracted data there should be clearly audible degradation of the audio tracks represented by that data.

Advantageously, audio compression methods such as MP3 compression developed by the Fraunhofer IIS, Fraunhofer Institut für Integrierte Schaltungen, Am Weichselgarten 3, D-91058 Erlangen, Germany, or MLP compression developed by Meridian Audio Ltd, may be employed to compress audio content contained in the second content file, such that a greater quantity of audio data may be contained in the storage capacity provided by the sub-code channel, thus increasing the amount of data available for repairing errors, and consequently increasing the number of points at which error-inducing copy-protection may be applied to the first content file.

An alternative embodiment is provided where the second content file is encoded in the program area of the disc. A typical audio CD can store 74 minutes of audio in the program area, yet many CD products provide less than 74 minutes of content material, therefore on such discs there is space in the program area to store a second content file. As will be appreciated by a skilled reader there are yet further embodiments providing a data-storage system which uses a means of encoding a first content file and at least one second content file onto a first data carrier, arranged to provide a method of extracting both the first and second content files, and a method of combining them to result in a copy of the first content file which is not degraded.

OTHER EMBODIMENTS

A further embodiment of the present invention is provided where the second content file contains data characterising the degradations which the first content file would suffer upon extraction, and which second content file data may be used to compute repair data or procedures which would be required in order to repair a degraded copy

5   of the first content file.

A yet further embodiment of present invention provides a data storage system where a degraded copy of the first content file is stored on an intermediate carrier such as a CD, flash memory, cache memory or in particular a web server or web cache, and the

10   second content file of data is stored on a separate carrier such as a smart-card or a web server, such that the second content file is the subject of a secure access control system, whilst degraded copy of the first content file is held on a high-capacity storage system which may be held locally or available remotely over a wide-bandwidth connection.   Such an embodiment is of interest in e-commerce systems

15   which are required to protect content files on a server or cache and to provide access to that content under the terms of a transaction. The present embodiment supports this process by providing access to a degraded or partially incomplete copy of a first data file on a publically accessible web-server or web-cache whilst providing controlled access to a second file of data which is required in order to yield a complete copy of

20   the first content file. It will be appreciated by those skilled in the art that benefits in terms of efficient caching of large content files, and reduced encryption overheads, and limited preview models, are all facilitated by this embodiment.

CLAIMS

1.   A data-storage medium comprising at least two data storage files, the first data storage file comprising data content with degraded data portions, said data medium also comprising at least one second data file, said second data file comprising data corresponding to the degraded portions of said first data file, said second data file being usable to correct the degraded portions of said first data file.

2.   A data-storage medium as claimed in claim 1, wherein said data system comprises a second data file containing checksum or CRC data for the purpose of detecting and correcting errors present in degraded portions of any data extracted from said first data file said second data file being usable to correct the degraded portions of said first data file.

3.   A data-storage medium as claimed in claim 1, said second data file comprising non-degraded data content corresponding to the degraded portions of the first data file, the content of second data file being usable to correct the degraded portions of the first data file.

4.   A copy protection system using a data-storage medium as claimed in any one of claims 1 to 3.

5.   A copy protection method using a data-storage medium as claimed in any one of claims 1 to 3, wherein the copy-protection method is constructed to introduce degradations into data extracted from said first data file.

5   6.   A data-access system using a data-storage medium as claimed in any one of claims 1 to 3.

7.   A data-access method using a data-storage medium as claimed in any one of claims 1 to 3, wherein the data-access method is constructed to repair

10   degradations of data extracted from said first data file, using said second data file.

The
Patent
Office

Application No: GB 9928558.7   **Examiner:** Keith Sylvan
Claims searched: 1-7   **Date of search:** 12 January 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

    UK Cl (Ed.S): G4A (AAP) G5R (RHB)

    Int Cl (Ed.7): G06F (1/00,12/14) G11B (20/00)

Other: Online: WPI, INSPEC, PAJ, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO98/54713 A1 C-Dilla. See the abstract.	-
A	WO98/52194 A1 Imation. See the abstract and page 7 lines 29-36.	-